

IDENTIFICATION OF CERTAIN DIFFUSE POROUS TREE SPECIES ACCORDING TO QUANTITATIVE INDICATORS OF THEIR ANATOMICAL ELEMENTS

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ABSTRACT

In spite of the different diameter and density of the vessels of diffuse porous species, they can be more or less similar in these characteristics. This study discusses the differences of the vessels in several Bulgarian local growing tree species which have only single row core rays.

There are measured the average diameter and density of the vessels. Using them, the area of the individual anatomical components is calculated. The mean and the variance are determined in order to be used as diagnostic indicators. An examination of the statistical significance of the samples is made in order to determine which of the anatomical features can be used to identify the wooden species.

Key words: diffuse porous wood species, poplar, populus, vessels, microscopy

INTRODUCTION

The identification of tree species on the anatomical elements of their wood is usually very difficult and requires high skills. However it is possible to use quantitative values of these indicators as diagnostic features [1, 2].

Poplars have diffuse porous wood, and are very similar in structure. Therefore, the identification of individual species is very difficult. They are one of the most common types of wood in Bulgaria. The wood is light and soft, made of thin-walled cells.

The anatomical parameters of each cell can be represented as a value belonging to different sets. Moreover, even within one annual ring may also be separated different sets. For example vessels in early and late wood are most often different in diameter and density. There are mathematical procedures that allow to compare values belonging to different sets. [3]

This study aims, using mathematical methods, to identify tree species belonging to a group with specific structure.

METHODS AND MATERIALS

The object of this study is the wood of *Populus tremula*, *Populus alba* and *Populus nigra*. Durable microscopic preparations for the study of anatomical posture are used. The extracted timber is typical for the species, and it is taken from the area of uniform annual rings.

One of the main characteristics of the timber in a study of the anatomical structure is the density of the vessel. It is also one of the anatomical parameters that can be set on the preparations with reflected light. It depends on the tree species and site conditions. It is defined as the number of vessels for the researched area.

Another important characteristic of the timber, which is directly observed in a study of the anatomical structure, is the diameter of the vessel. It can also be defined on samples with reflected light. It depends on the wood species of site conditions and the location of the vessel in the annual ring. It is usually measured in tangential direction, on the cross section.

The area of the vessel is calculated from the average diameter, as the shape of the vessel is considered a circle. The total area of the vessel is calculated also using its density.

RESULTS AND DISCUSSION

The mean values for the density of the early vessels range from 163.5 count/mm⁻² (white poplar) to 206.5 count/mm⁻² (aspen). It was found that the values of the black poplar and aspen are similar. Overall, the results obtained were similar to the data in the literature [3, 5]. The data of the white poplar and aspen are relatively collected with a small variance, while the black is significantly (almost double) scattered around the mean (Fig. 1).

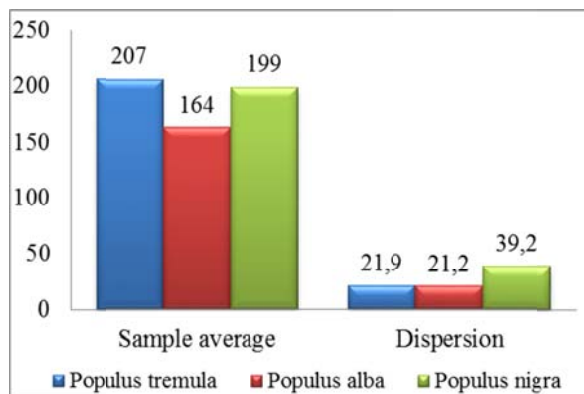


Figure 1: Density of the early vessels count/mm²

The mean values for the density of late vessels vary slightly from 127 count/mm (white poplar) to 141 count/mm (aspen). These data are also similar to the data in the literature. Characteristic is that in density and placement, the readings of the three poplars are close. It can be concluded that the latter vessels are evenly spaced.

The diameter of the early vessels varies slightly from 46,04 μm (aspen) to 54,30 μm (white poplar) (Fig. 2). The obtained values of white and black poplar are larger ones. The diameter of the vessel of the white and black poplar was significantly greater than that of aspen, which is confirmed in the

study of literature [3, 5]. The data of the white poplar and aspen are relatively collected, while the black is significantly (almost double) scattered around the average.

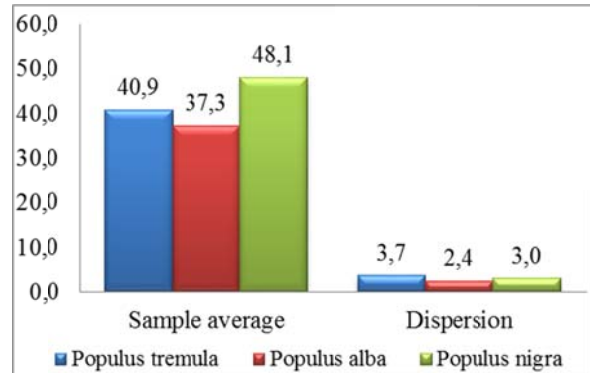


Figure 2: Mean diameter of late vessels, μm

The mean diameter values of the late vessels range from 37,35 μm (white poplar) to 48,08 μm (black poplar). These data are also similar to the data in the literature (Fig. 2., by Enchev, E., 1970). Characteristic herein is that the diameter of the latter vessels in the white poplar and aspen are close, while the iron is considerably greater. Data on white and black poplar are relatively collected, while those of aspen are scattered around the average. Furthermore later vessels of black poplar are greater than those of the aspen.

The mean values for the area of the early vessel range from 16,75 μm² (aspen) to 23,23 μm² (white poplar). In contrast, the values of the white and black poplar, which is higher than and close to the data in the literature, those of aspen are lower [3,5].

The data of the white poplar and aspen are relatively equal, and gathered around the average asymmetric, while the black poplar are distinguished from the others (Fig. 3). They show that in the value of the area of the early vessel, white and black poplar are similar, but the area of the later vessels resemble aspen and white poplar. For earlier

vessel black poplar could be concluded that the surface area is smaller than the others, but the values are dispersed from the other two species.

The mean values for the area of the vessels varies slightly later than 11,00 μm^2 (white poplar) to 18,23 (black poplar) μm^2 . These data are similar to the data in the literature [3,5]. Values of aspen and white poplar are significantly close to the black poplar in the largest area.. The data of the white poplar are relatively collected, and those of the black poplar and aspen are approximately equal, but scattered around the average asymmetric.

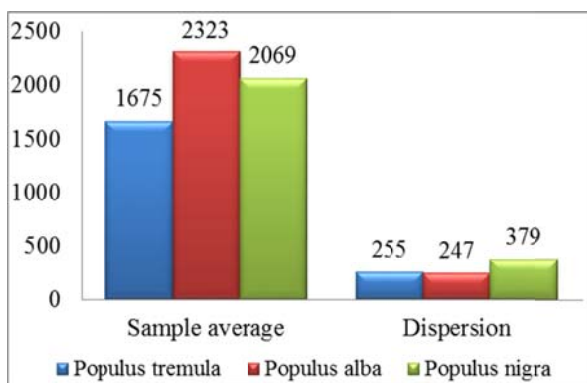


Figure 3: Area of an early vessel, μm^2

The mean values for the total area of early vessels vary slightly from 0,34 mm^2 (aspen) to 0,40 mm^2 (black poplar). The values show that the aspen has the smaller area, but more dispersion. The differences between it and the black poplar are the

values of the surface area since the variances are equal. Values of white and black poplar are similar, but the difference in variances of these is large.

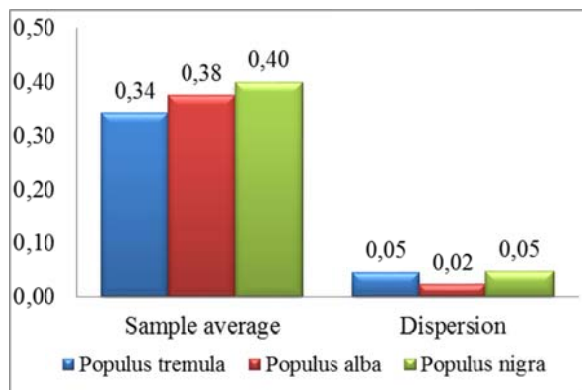


Figure 4: Total area o the early vessels, mm^2

The mean values for the area of late vessels range from 0,14 mm^2 (white poplar) to 0,24 mm^2 (black poplar). The characteristic feature here is that in the late vessels it is observed a similar dispersion of the values of all three types. Differences between mean values, however, are si large.

RELATIONSHIP BETWEEN INDICATORS OF VESSEL

For a more precise definition of the differences between values, the statistical significance of the sample was examined. This type of variance analysis can prove or refute the differences between the values of the individual anatomical features.

Table 1: Statistical significance of the differences of the individual samples (in blue showed no significant difference, and red - not significant)

Sample		Repetitions	Average	Dispersion	ν	$t_{0,01; \nu}$	σ^2	Correlation between sample		
Density of the early vessels, count/ mm^2								1:2	1:3	2:3
Populus tremula	1	21	206,5	21,86	40,00	2,42	478	4,58	3,47	
Populus alba	2	7	163,5	21,19	12,00	2,68	449			0,40
Populus nigra	6	15	169,3	39,17	28,00	2,46	1534	2,42	2,68	2,46
Density of the later vessels, count/ mm^2								1:2	1:3	2:3

Sample		Repetitions	Average	Dispersion	ν	$t_{0,01; \nu}$	σ^2	Correlation between sample		
Populus tremula	1	21	141,1	23,56	40,00	2,42	555	1,52	1,54	
Populus alba	2	7	127,0	18,82	12,00	2,68	354			0,38
Populus nigra	6	15	130,2	18,12	28,00	2,46	328	2,42	2,68	2,46
Mean diameter of early vessels, μm								1:2	1:3	2:3
Populus tremula	1	21	46,04	3,517	40,00	2,42	12	5,86	3,61	
Populus alba	2	7	54,30	2,914	12,00	2,68	8			1,78
Populus nigra	6	15	51,11	4,710	28,00	2,46	22	2,42	2,68	2,46
Mean diameter of late vessels, μm								1:2	1:3	2:3
Populus tremula	1	21	40,87	3,668	40,00	2,42	13	2,59	6,37	
Populus alba	2	7	37,35	2,432	12,00	2,68	6			8,60
Populus nigra	6	15	48,08	2,993	28,00	2,46	9	2,42	2,68	2,46

The survey on the density of the vessel showed that early diagnostic sign vessels can be used to identify the other two aspen and poplar. Differences between them, however, in this indicator are negligible and the white poplar can not be distinguished from the black density in the early vessels. The density of the vessels later can not be used as a diagnostic indicator between the examined species.

Upon examination of the diameter of the vessel, the investigation showed that, depending on the early vessel may differ from the other two aspen species. The difference in diameter between the white and black poplar, however minor these two samples match can be considered as one. The . types can be distinguished from each other. Differences in diameter of the latter vessels were statistically significant, i.e. this anatomic element can be successfully used as a diagnostic indicator.

An area of early vessels repeated trends was obtained in the two previous anatomical indicators. The area of the latter is very different vessels and the three types may be successfully used to identify each other.

The tested variations of the total area of the early vessels indicate that they were statistically significant only to the black poplar and aspen. In tardive vessels all differences are statistically significant, i.e. using this indicator, the target species can be successfully differentiated.

CONCLUSIONS

The survey showed that the anatomical elements and their quantitative values may carry diagnostic information. The most important conclusions from it are:

- Density of early vessels could be used as a diagnostic sign only between white and black poplar, while later vessels show no significant differences.
- The diameter of the vessels can be used for authentication of the black poplar and aspen because of differences in the mean values and variances.
- The area of a separate vessels can be used as a diagnostic sign, because of the differences in the mean values and variances.

- The total area of the vessel can also be successfully used for the identification of the target species of poplar.
- Prior to allegedly anatomical elements with their quantitative values which can be used for recognition must be carried out a study on the variation in the volume of their stem.

REFERENCES

1. Bardarov, N. (2009). Study on the size of the cell cavities as a diagnostic sign. Collection of scientific papers „Innovations in Forest Industry and Engineering Design”, Sofia, pp. 72–75. (in Bulgarian).
2. Ganchev, P. (1971). Studies on the anatomical structure of the wood of some varieties of Euro-American poplar. Academy of Agricultural Sciences. Forestry science, Sofia, 8/4, c. 15–20 (in Bulgarian).
3. Entchev, E. (1975). Structure, properties and use of wood. Poplar – *Populus* sp. – B: Advances in support of forest management techniques. Scroll Wood industry, year VII, 1975, № 8, 3–7, (in Bulgarian).
4. Bardarov, N., D. Mladenova. (2013). Determination of tree species using quantitative indicators of their vascular cells. Innovation in woodworking industry and engineering design. Sofia, Innovation in woodworking industry and engineering design, ISSN 1314-6149, vol. II, Sofia, 2013, pp. 106–113.
5. Wagenführ, R., Chr. Scheiber. Holzatlas. (1996). VEB Fachbuchverlag, Leipzig, 177–178.
6. Benkova, V.E., Fr.H. Schweingruber. (2004). Anatomy of Russian woods. Bern – Stuttgart, Haupt.